Jun 10th, 10:20 AM - 10:40 AM

Fish Passage Enhancement at York Haven Dam – Reconnecting the Lower Susquehanna River

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Fish Passage Enhancement at York Haven Dam Reconnecting the Lower Susquehanna River

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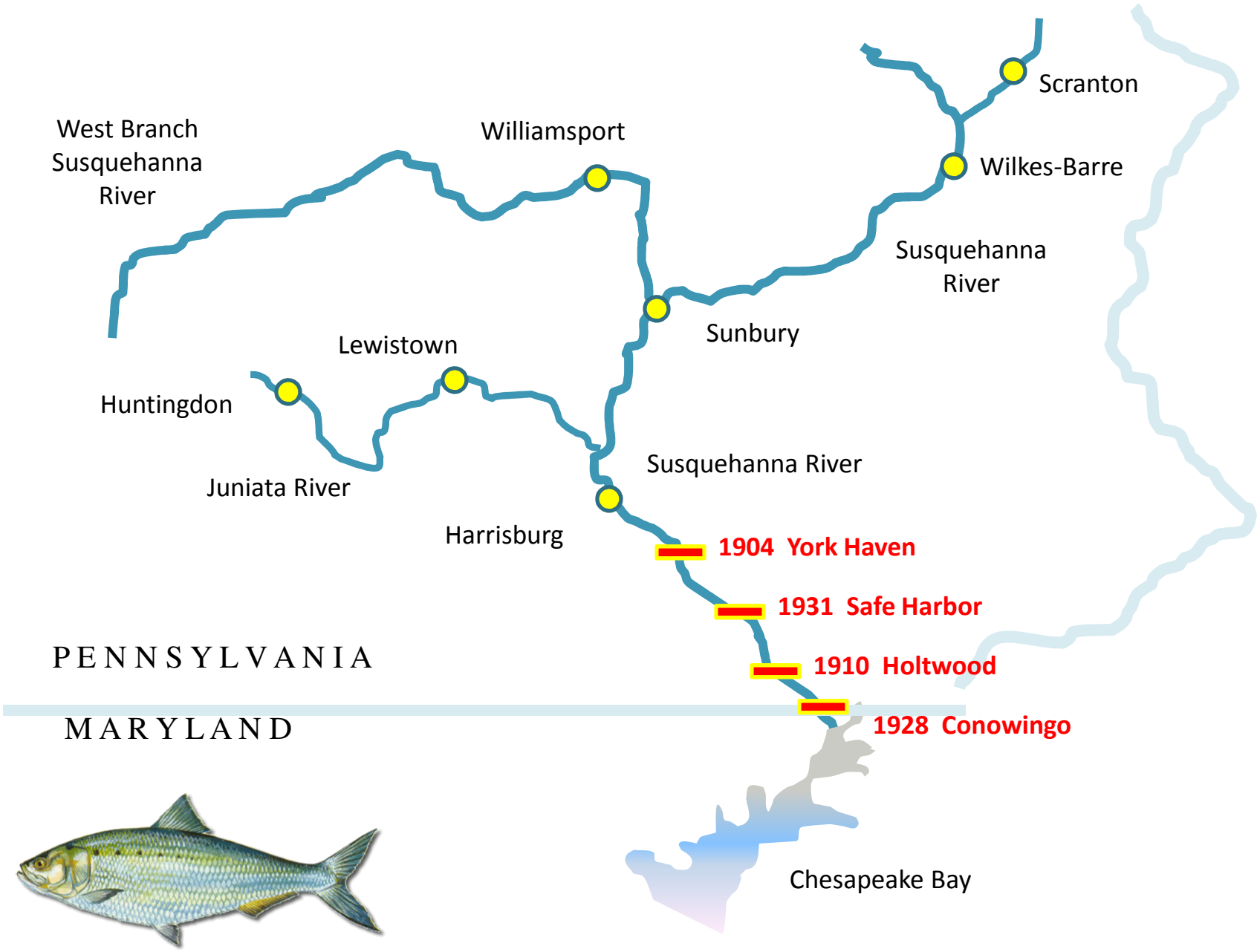
June 10, 2014

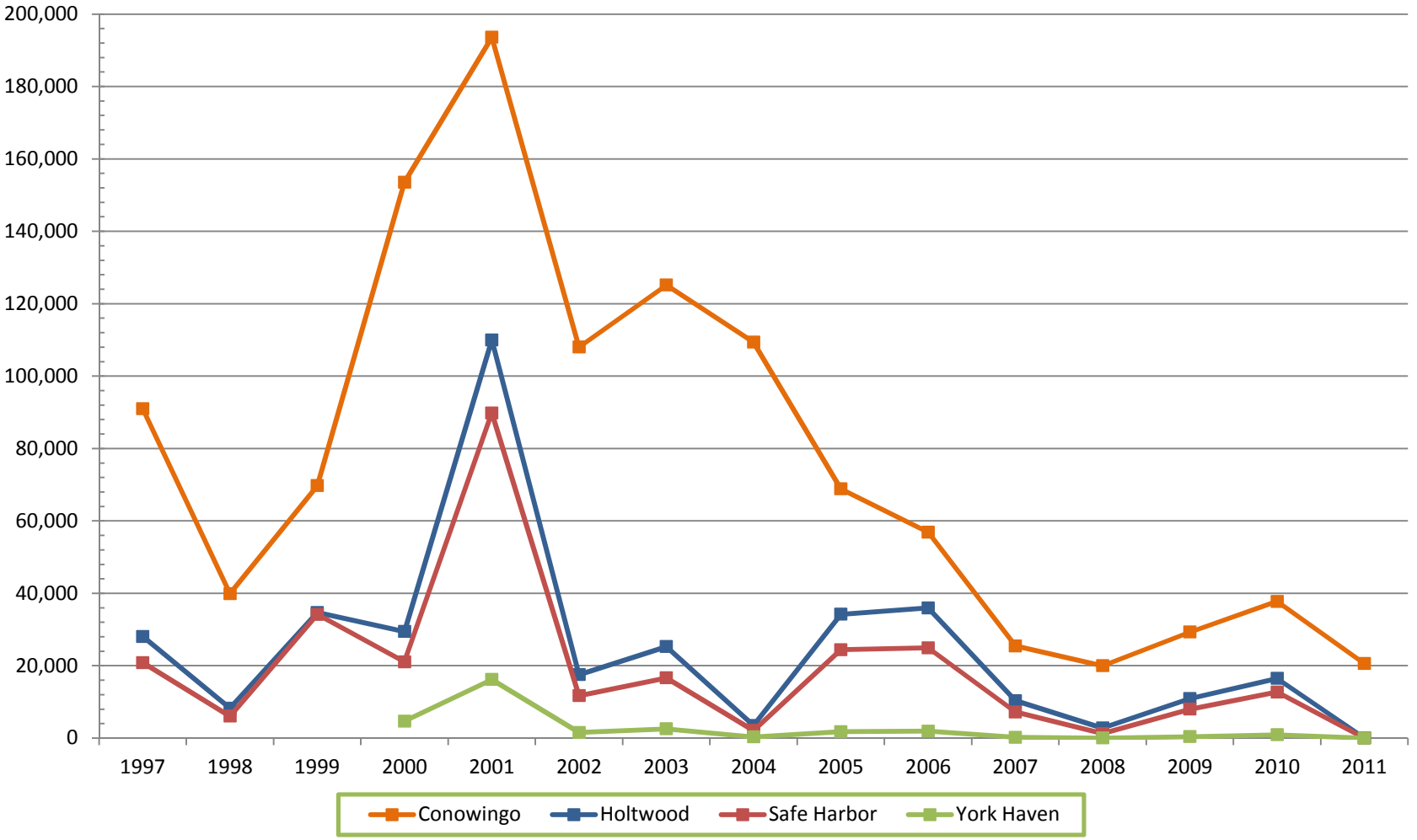

Scranton
West Branch
Susquehanna
River
Williamsport
Wilkes-Barre
Susquehanna
River
Sunbury
Lewistown
Huntingdon
Susquehanna River
Juniata River
Harrisburg
1904 York Haven
1931 Safe Harbor
PENNSYLVANIA
1910 Holtwood
MARYLAND
1928 Conowingo
Chesapeake Bay

Fish Passage Restoration Goals

- **2010 SRAFRC Migratory Fish Management and Restoration Plan for the Susquehanna River Basin**
  - Restore self-sustaining, robust, and productive stocks of migratory fish
  - 2 million American shad and 5 million river herring spawning upstream of the York Haven Dam.
  - Goals for American eel and other migratory species are yet to be determined

- **2013 SRAFRC American Eel Addendum**
  - Ensure that every American eel that approaches Conowingo Dam is passed upstream into the Susquehanna River Basin

Susquehanna River
American Shad Passage 1997-2011



York Haven Project Layout
2 Miles from Powerhouse to East Channel Fishway

← East Channel Dam & Fishway
928 ft., vertical slot ladder

← Three Mile Island
separates east/main channels

← Main Dam spillway
4,970 ft. long

← Headrace Wall
3,000 ft. long

← Powerhouse
20 units, and sluice gate (370 cfs)

Upstream Passage

Performance Measures

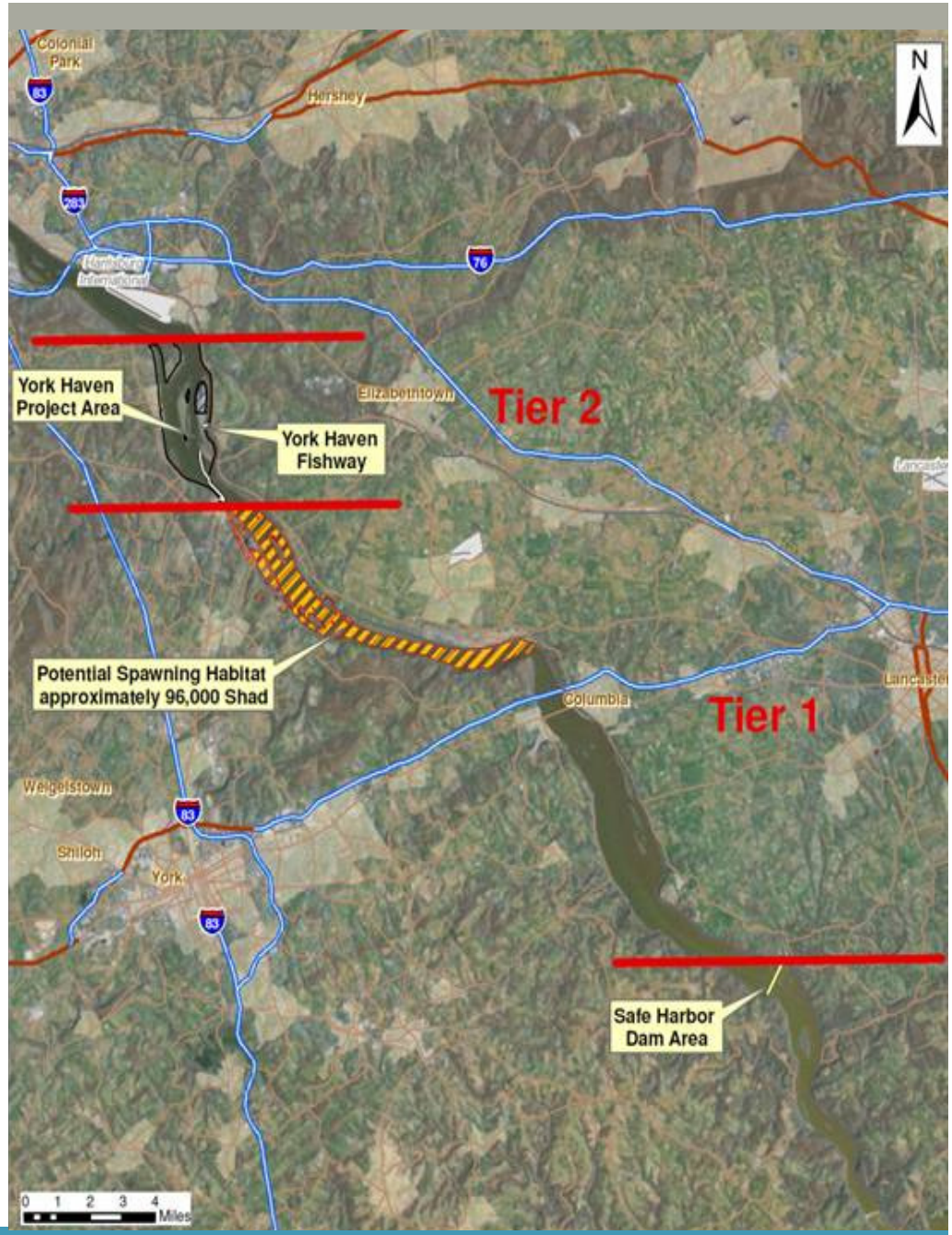
- 85% upstream passage of American shad
- Provide adequate upstream passage (safe, timely, effective and efficient) for American eel
- Provide adequate upstream passage (safe, timely, effective and efficient) for all other migratory fish

2010 Upstream American Shad Migration Study

- Total of 17 monitoring stations and 21 antenna zones were installed from Safe Harbor tailrace to above York Haven Dam
- Upstream migration monitoring spanned the entire spawning season of April 23 through June 15, 2010
- American shad were tagged and released in six groups spanning the early to middle portions of spawning season

2010 Study Results

- 180 tagged shad left at Safe Harbor Dam
- 127 shad arrived at York Haven Project
- 70 % migration efficiency over the 26 river-miles between dams

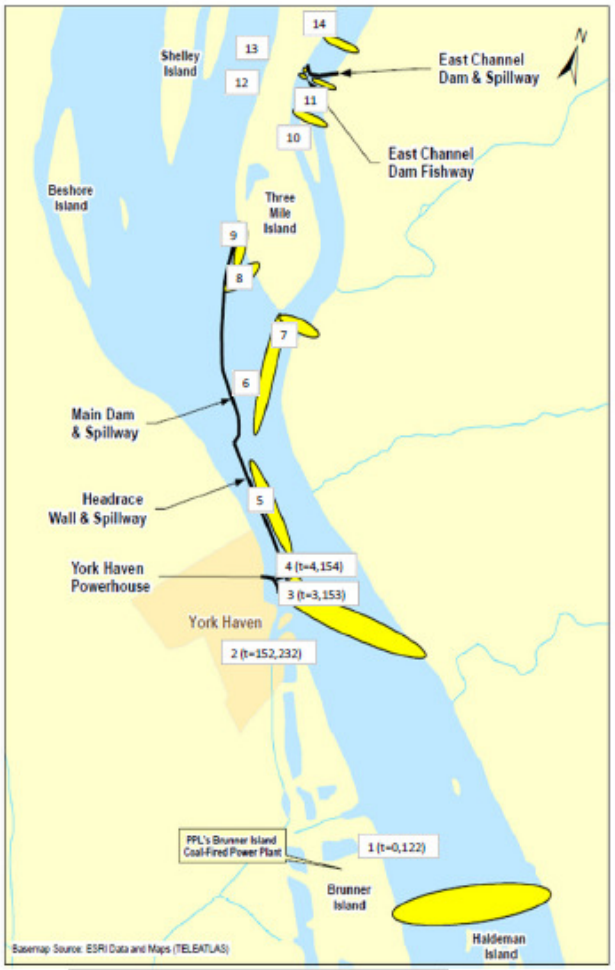


2010 Study Results

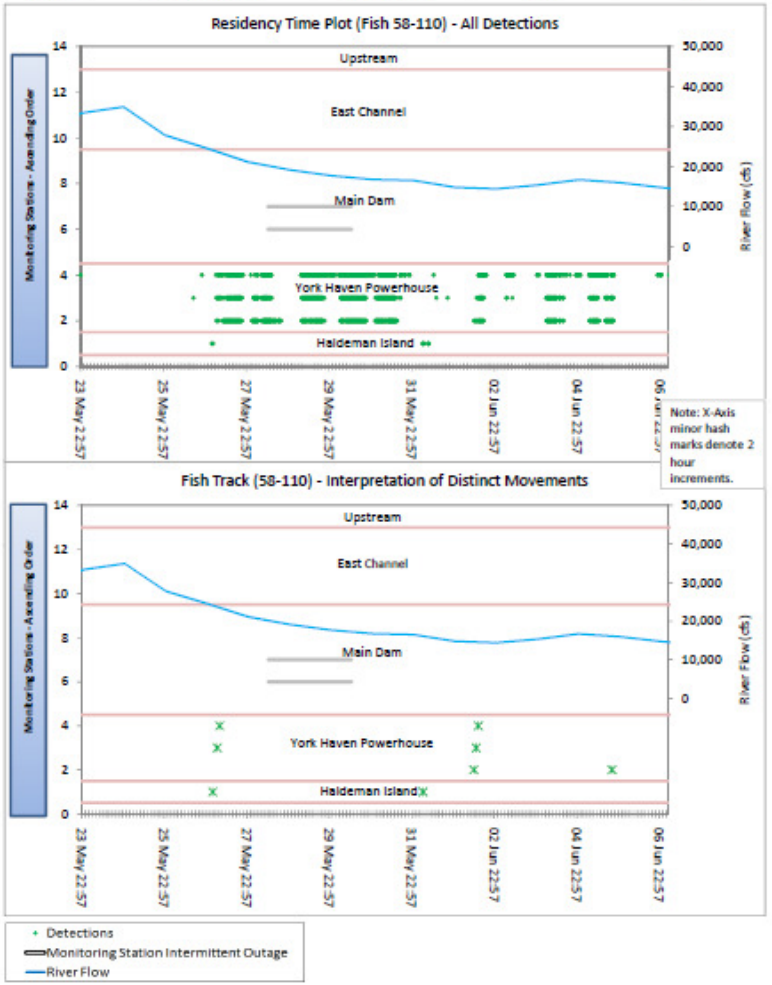
- 3.9% of tagged shad arriving at the Project passed upstream through the East Channel fish ladder
- Historically, the percentage of Safe Harbor passed shad also passing at York Haven has varied from 22% to 2%
- Fish passage enhancement studies initiated

Data Analysis Methods – Shad Movement

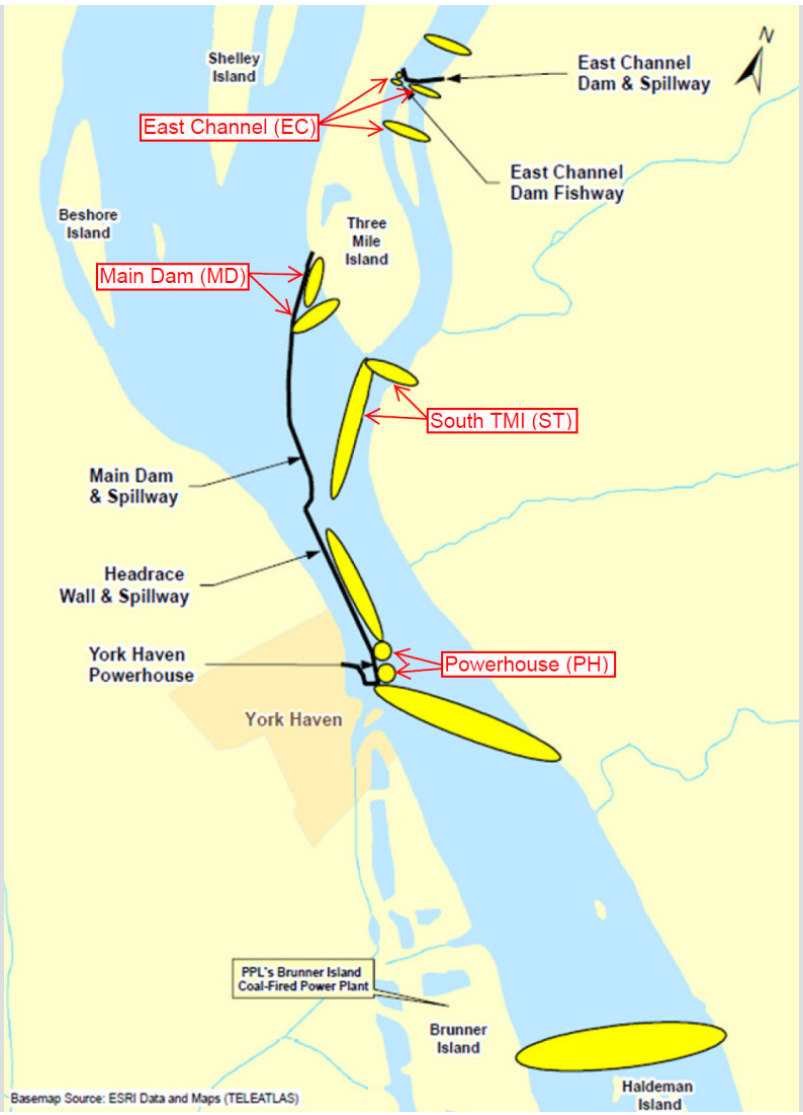
York Haven American Shad Telemetry Results Summary: Station Detection and Elapsed Time (hours)
Fish Number 58-110

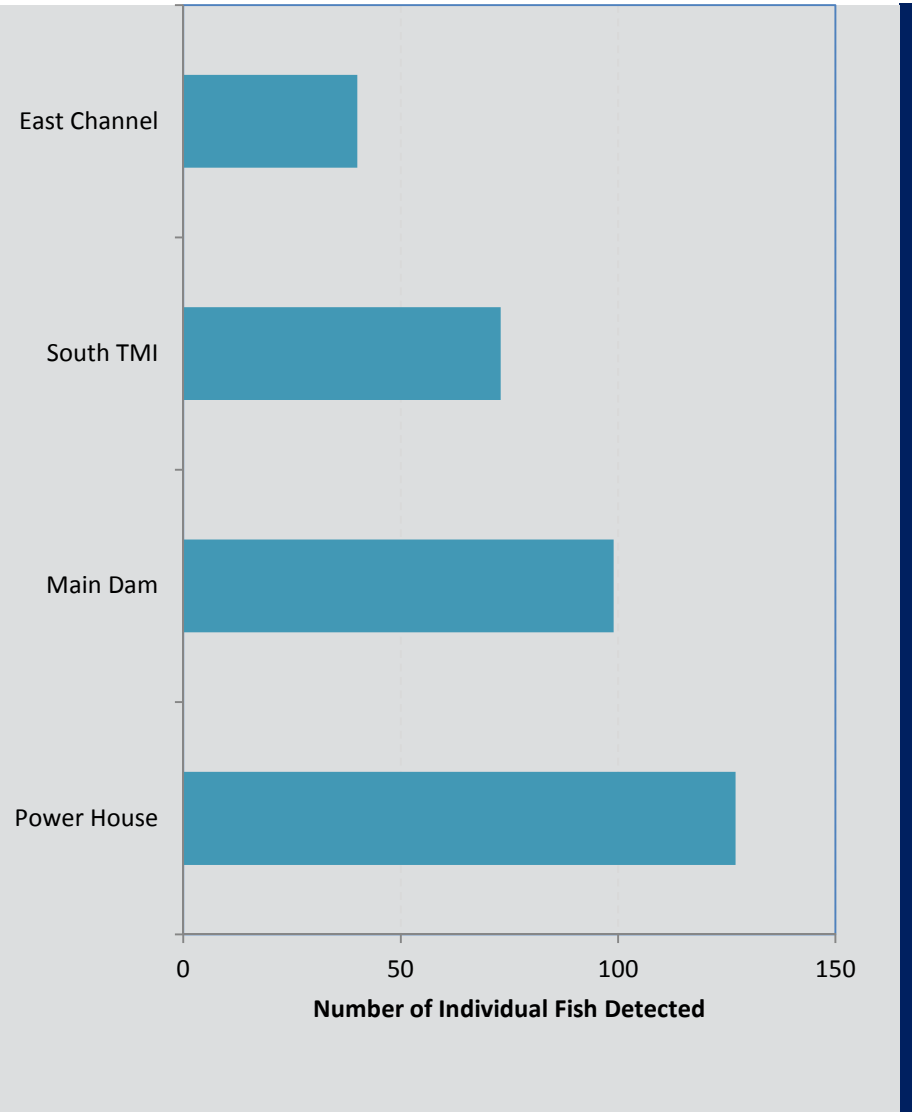


Fish ID	Release Location	Release Date/Time	Length (mm)	Sex
58-110	Safe Harbor Fishway	5/18/2010 12:10	430	M



2010 Study Results – Movements in Project Area





Fish Lift at South End of Powerhouse?

- Initially, results led to consideration of powerhouse fish lift, however;
  - Poor fish lift results at other sites
  - Logistically difficult and risky design at York Haven

How to Improve Upstream Passage?

- Unique layout of project
- Shad exhibited searching behavior in 2010 study
- Main dam apex second most frequently visited location
- PFBC – requested consideration of nature-like fishway (NLF) at dam apex
- Luther Aadland brought on as design advisor
- Supplemental attraction flow at NLF (> 5% River Q) is a key design element to attract fish to apex
- Four NLF layouts considered

Nature-Like Fishway Concept

Nature-Like Fishway Advantages

- Fits into site geometry following natural channel thalweg gradient and uses dam spillway to direct fish to entrance
- Supplemental attraction flow (> 1,000 cfs for shad) will allow migration from powerhouse to NLF
- American eel and all resident migratory species will also benefit through restored connectivity year-round (> 200 cfs)
- All parties agreed on this approach to upstream passage

Downstream Passage

Performance Measures

- 80% downstream passage survival of post-spawn American shad
- 95% downstream passage survival of Juvenile American shad
- 85% downstream passage survival of silver American eels

Spills Over Dam

Important Component of Downstream Passage

Powerhouse →17,000 cfs

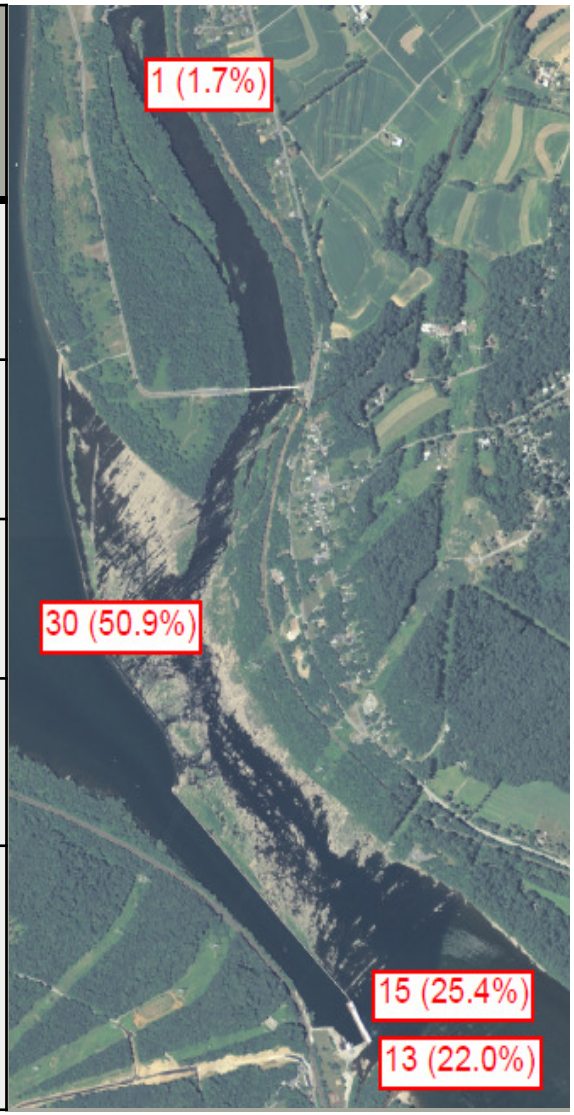
- Adult post-spawn shad & river herring season
  - May 90%
  - June 55%
- Juvenile American shad & silver American eel season
  - October 27%
  - November 59%
  - December 74%

Sluice Gate in Powerhouse Forebay

Opened to provide passage for shad that do not pass over the dam spillway

2012 Study Adult Post-Spawning Shad Passage Routes

Downstream Passage Route	Number of Shad
Main Dam Spillway	30
Turbines	15
Sluice Gate	13
East Channel	1
Total Number of Shad Arrived at York Haven	59



Conclusions – Adult Post-Spawners

- 75% of shad passed downstream through preferred passage routes (non-turbines)
- Good response to sluice gate openings (10 of 17 passed immediately, 13 of 17 total)
- Overall downstream passage survival likely > 85%
- Performance measure (80% survival) met
- No further enhancement necessary


EAST CHANNEL FISHWAY
PROPOSED NATURE LIKE FISHWAY
EXISTING FOREBAY SLUICE GATE
500 0 500 1,000 1,500 2,000
Feet
USDA-FSA-APFO Aerial Photography Field Office (National Agricultural Imagery Program (NAIP). Digital ortho imagery, 1 meter resolution, 2010.


YORK HAVEN

Current Status/Experience at Project

American Shad Juveniles

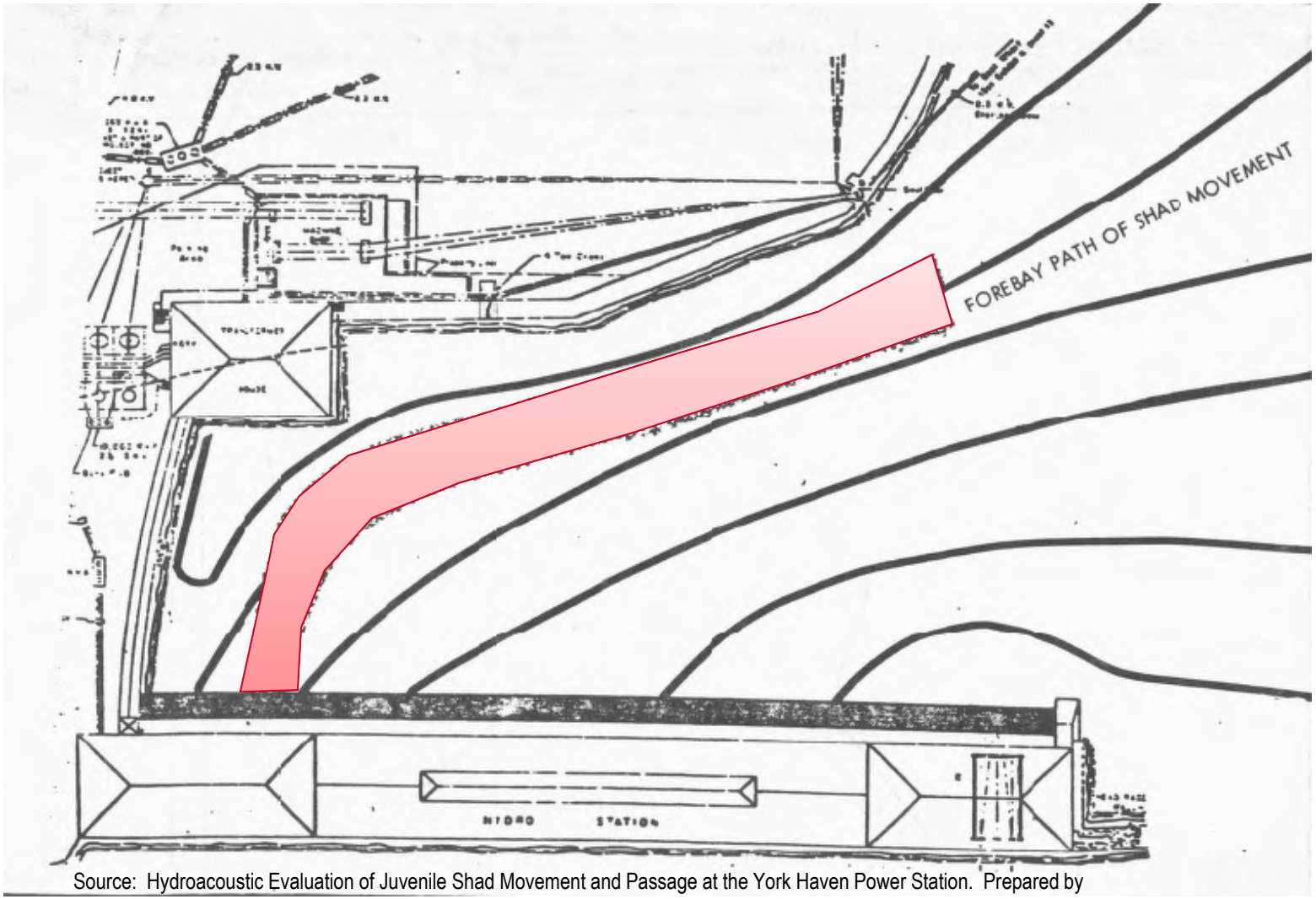
- Start: Early October
- End: Mid November
- Behavior: Studied extensively at York Haven 1985-1993. Surface oriented, move after dusk and mostly before midnight, gather at Unit 1/sluice gate vicinity or go over spillway.

Silver American Eel

- Start: No site specific data – Mid October?
- End: No site specific data – Mid December?
- Behavior: Bottom oriented? Move dusk to dawn mostly before midnight during freshets and/or within days of the new moon.

Site-specific behavior is unknown, not currently present at York Haven in numbers sufficient to study.

1986 Shad Movement and Drogue Path



Source: Hydroacoustic Evaluation of Juvenile Shad Movement and Passage at the York Haven Power Station. Prepared by Barnes-Williams Environmental Consultants. Fall 1986.

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Balloon Tag Study
(Normandeau 2000)

Unit # 3 juvenile shad survival was 92.7 %

(represents primary juvenile shad path)

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JUVENILE AMERICAN SHAD SURVIVAL RATES FOR PROJECT TURBINES

Turbine Type (Unit Nos.)	Survival Percentage *					
	Empirical Studies American Shad Juveniles			Turbine Blade Strike American Shad Juveniles		
	Mean	Min	Max	Mean	Min	Max
Kaplan (1-4)	**92.7%**	82.0%	100.0%	95.9%	91.6%	98.0%
Propeller (5)	-	-	-	**95.3%**	91.3%	97.4%
Propeller (6)	-	-	-	**96.5%**	93.5%	98.0%
Double-Francis (7-13 and 15-20)	**77.1%**	66.0%	88.0%	93.6%	92.4%	94.9%
Single Francis (14)	-	-	-	**92.5%**	90.9%	94.1%

Baseline and Post NLF Downstream Survival
2002 Protocol - Sluice Gate and Turbine Sequencing

Baseline	**Silver Eel**	**Exceedance Flow and Month**	**20% Exceedance**			**50% Exceedance**			**80% Exceedance**		
			Oct	**Nov**	**Dec**	**Oct**	**Nov**	**Dec**	**Oct**	**Nov**	**Dec**
		Monthly Total Project Survival	77.3%	87.2%	90.8%	77.0%	76.2%	81.7%	82.4%	76.7%	72.5%
		Average Project Survival	85.1%			78.3%			77.2%		
		Total Average Project Survival	**80.2%**								
	Juvenile Shad	**Exceedance Flow and Month**	**20% Exceedance**			**50% Exceedance**			**80% Exceedance**		
			Oct	**Nov**	**Dec**	**Oct**	**Nov**	**Dec**	**Oct**	**Nov**	**Dec**
		Monthly Total Project Survival	87.7%	93.0%	95.0%	91.6%	87.1%	90.1%	94.2%	91.3%	85.9%
		Average Project Survival	91.9%			89.6%			90.5%		
		Total Average Project Survival	**90.6%**								
Baseline With NLF	**Silver Eel**	**Exceedance Flow and Month**	**20% Exceedance**			**50% Exceedance**			**80% Exceedance**		
			Oct	**Nov**	**Dec**	**Oct**	**Nov**	**Dec**	**Oct**	**Nov**	**Dec**
		Monthly Total Project Survival	77.3%	87.2%	90.8%	80.2%	76.2%	81.7%	86.4%	80.0%	74.5%
		Average Project Survival	85.1%			79.4%			80.3%		
		Total Average Project Survival	**81.6%**								
	Juvenile Shad	**Exceedance Flow and Month**	**20% Exceedance**			**50% Exceedance**			**80% Exceedance**		
			Oct	**Nov**	**Dec**	**Oct**	**Nov**	**Dec**	**Oct**	**Nov**	**Dec**
		Monthly Total Project Survival	87.7%	93.0%	95.0%	93.8%	87.1%	90.1%	95.5%	93.5%	87.2%
		Average Project Survival	91.9%			90.3%			92.1%		
		Total Average Project Survival	**91.4%**								

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Water Power for the Future

Can 2002 Protocol be adjusted to accommodate current juvenile shad and silver eel performance measures?

- 95% downstream passage survival of Juvenile American shad
  (91% calculated with NLF)
- 85% downstream passage survival of silver American eels
  (81% calculated with NLF)

Downstream Passage
Survival Enhancement Facilities Considered

- Angled Bar Rack (upstream or at powerhouse intakes)
- Trash Rack Replacement
- Alden Weir
- Louvers
- Floating Boom / FGS
- Solid Guide Walls
- Overlay Racks
- Inclined Plane Screens

Conclusions from Analysis of Current Conditions and Alternatives

Juvenile American Shad

- With NLF implementation + procedure to open sluice gate during October and November, juvenile shad survival rate is > 91% based on 1:1 fish to flow desktop model.
- If previous studies of migration path are accurate, 95% survival should be attained
- Passage alternatives have high cost with very marginal improvement to shad passage survival.

Silver American Eel

- With NLF implementation + procedure to open sluice gate during November and December, estimated Silver eel survival rate is > 81%. based on 1:1 fish to flow desktop model.
- Major passage alternatives (angled bar rack & trash rack replacement) have very high cost and present significant impingement risk for silver eels.
- The only realistic approach for eels is adaptive management to provide an opportunity to study and observe eel behavior when a population exists.

Summary of Fish Passage Enhancements at York Haven

UPSTREAM PASSAGE

- Nature-Like Fishway at main dam apex with >5% river Q attraction flow during shad spawning run
- Operate Nature-Like Fishway year-round at 200 cfs to reestablish river connectivity and habitat
- Maintain original East Channel vertical slot fishway April – November with reduced attraction flow
- Evaluate upstream passage effectiveness for 85% upstream passage of American shad
- Adjust Nature-Like Fishway hydraulics, if necessary, to achieve performance measures

Summary of Fish Passage Enhancements at York Haven

DOWNSTREAM PASSAGE

- High spill frequency will continue to be the primary route of downstream passage
- Nature-Like Fishway will provide a new route for downstream migration
- Upgrade sluice gate exit to enhance hydraulics and fish survival probability
- Continue sluice gate operation and preferred turbine sequencing during outmigration seasons
- Perform studies to evaluate juvenile American shad turbine avoidance in forebay to achieve 95% passage survival performance measure
- Once silver American eel runs are restored, study migration patterns and attainment of 85% survival
- If necessary, reassess fish guidance enhancements to achieve downstream performance measures